

EP 40666 ②

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 August 2001 (30.08.2001)

PCT

(10) International Publication Number
WO 01/63992 A1

(51) International Patent Classification?: **H05K 3/46, B32B 31/00**

(21) International Application Number: **PCT/US01/05892**

(22) International Filing Date: 23 February 2001 (23.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/512,971 24 February 2000 (24.02.2000) US

(71) Applicant: **HONEYWELL INTERNATIONAL INC.** [US/US]; 101 Columbia Road, P.O. Box 2245, Morristown, NJ 07962-2245 (US).

(72) Inventors: **POMMER, Richard; 32266 Via Del Nido, Trabuco Canyon, CA 92679 (US). BANISTER, Bradford; 33156 Sca Bright, Dana Point, CA 92629 (US). ROETERS, Glen; 9872 Voyager Circle, Huntington Beach, CA 92646 (US). MCELREA, Simon; 32266 Via Del Nido, Trabuco Canyon, CA 92679 (US). KUMAR, Rajesh; 74682 Bahamonde, Mission Viejo, CA 92692 (US).**

(74) Agents: **CRISS, Roger, H. et al.; Honeywell International Inc., 101 Columbia Avenue, P.O. Box 2245, Morristown, NJ 07960 (US).**

(81) Designated States (*national*): CA, CN, JP, KR, MX, SG.

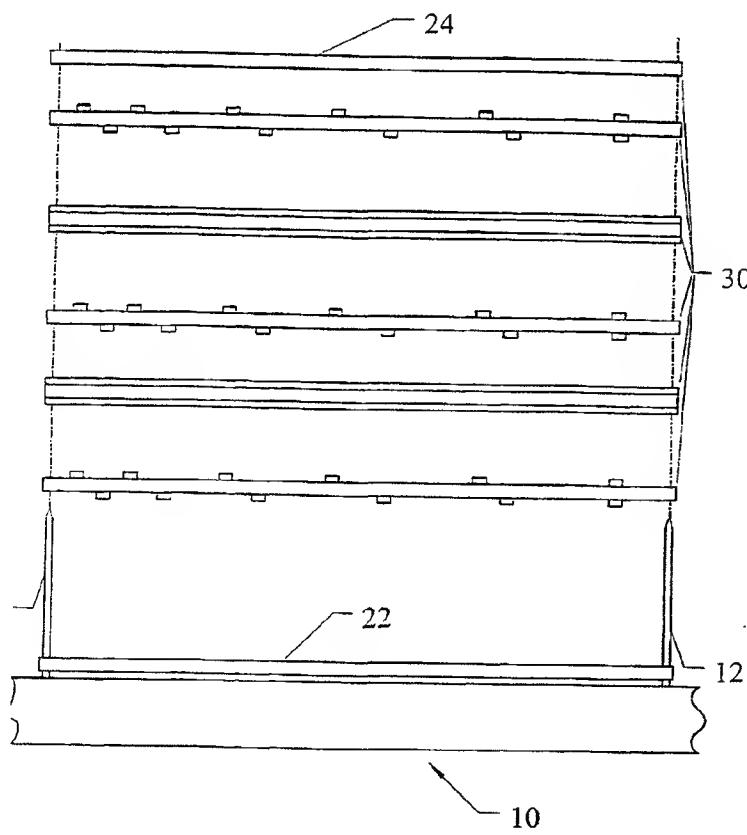
(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

[Continued on next page]

(54) Title: ALIGNMENT PLATE WITH MATCHED THERMAL COEFFICIENT OF EXPANSION



WO 01/63992 A1



(57) Abstract: Proper registration between layers of a laminated multi-layer interconnect can be achieved by precisely dimensioning the alignment plate (10), selecting the materials of which the alignment plate (10) is composed to have the same thermal coefficient of expansion as the layers (30) being laminated, and/or providing the alignment plate (10) with pins (12) sized to be equal to or larger than the alignment/registration holes (32) of the layers (30).



Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ALIGNMENT PLATE WITH MATCHED THERMAL COEFFICIENT OF EXPANSION

Field of The Invention

The field of the invention is lamination of dielectric based layers.

Background of The Invention

When laminating multiple layer pairs and bond-plys to form a multiplayer interconnect, it is important to align the layers as well as possible to insure proper registration between layers. One method for doing so involves providing an alignment plate comprising tooling pins and stacking layers to be laminated on the plate so that the plate tooling pins pass through alignment/registration holes in each layer.

Obtaining proper registration is sometimes made more difficult because of the tendency of the alignment plate dimensions to change with changes in temperature of the alignment plate. When the dimensions of the alignment plate change, the spacing between tooling pins changes as well. As a result, a layer may be distorted as a result of being stretched or compressed by such changes in spacing.

To avoid stretching or compressing a layer as the plate's temperature changes, it is possible to utilize registration holes in the layers which are large enough so that changes in positions of the pins simply result in their movement within the registration holes without stretching or compressing the layer. Such a solution is less than desirable, however, as it allows movement of the layers on the pins with such movement making it more difficult to achieve proper registration between layers.

Thus, there is a continuing need for improved lamination methods and devices which minimize registration problems resulting from temperature changes to the alignment plate.

Summary of the Invention

Methods and apparatus are provided which facilitate proper registration between layers when creating a laminated multi-layered device such and an integrated circuit (IC) interconnect. In particular, proper registration can be achieved by precisely dimensioning the alignment plate,

selecting the materials of which the alignment plate is composed to have the same thermal coefficient of expansion (TCE) as the layers being laminated, and/or providing the alignment plate with pins sized to be equal to or larger the alignment/registration holes of the layers.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief Description of The Drawings

Fig. 1 is a side view of an alignment plate embodying the invention.

Fig. 2 is a perspective view of an alignment plate embodying the invention.

Fig. 3 is a schematic of a method embodying the invention.

Detailed Description

Referring first to figures 1 and 2, an alignment plate 10 comprises tooling pins 12, and may be used to laminate layers 30, possibly by stacking and sandwiching layers 30 on tooling pins 12 and between release sheets 22 and 24. Alignment plate 10 is preferably constructed from a material having the same or approximately the same thermal coefficient of expansion (TCE) as layers 30. Tooling pins 12 preferably have a diameter equal to or greater than the diameter of alignment holes 32 of layers 30.

Referring to figure 3, a preferred method of lamination comprises: step 100, providing a plurality of layers 30 to be laminated; step 200, determining the TCE of the layers 30 to be laminated; step 300, providing an alignment plate 10 having approximately the same TCE, and step 400, stacking the plurality of layers 30 onto the alignment plate 10. If layers 30 and alignment plate 10 have the same TCE, the layers and plate will expand and contract together. In preferred embodiments, an alignment plate 10 will have a TCE close enough to the TCE of the layers as to maintain an alignment of $\pm 5\text{-}20\mu\text{m}$. For polyimide film layers, copper alignment plates will likely have TCEs which match the TCEs of the layers sufficiently as to maintain an alignment of $\pm 5\text{-}20\mu\text{m}$. Approximately the same as used in regard to the TCEs of the alignment plate 10 and layers

simply means that any difference in expansion and contraction of the copper plate 10 relative to layers 30 is small enough so that any misalignment caused by any such difference falls within acceptable bounds. However, it is contemplated that it would be particularly beneficial if the greatest difference between the TCE of alignment plate 10 and the average TCE of the layers be less than 2 ppm (parts per mill).

Preferred methods will also comprise: lazing registration/alignment holes 32 in the layers 30 to be laminated, the registration holes 32 having a diameter at least as large as the diameter of the tooling pins 12 of the alignment plate 10. The tooling pins 12 have at least the same diameter as the alignment/registration holes 32 in the layers 30 so as to prevent any movement of the layers 30 once they are positioned on the pins. The need for overly large registration holes to compensate for different rates of expansion between the alignment plate 10 and layers 30 is minimized if layers 30 and alignment plate 10 have similar TCEs. It is contemplated that lazing the registration holes 32 such that their diameters are at least 0.5 μ m smaller than the diameter of the tooling pins would be particularly beneficial.

It is also preferred that the materials comprising layers 30 be chosen so that layers 30 have substantially similar TCEs. Having all the layers 30 having substantially similar TCEs prevents distortion of one or more layers 30 because of differences in TCE between layers and between any one layer and the alignment plate 10. Substantially similar as used in regard to the TCEs of the layers simply requires that the individual layers expand and contract similarly enough that any misalignment resulting from difference in rates of expansion fall within acceptable bounds. However, it is contemplated that it would be particularly beneficial if the greatest difference in TCE between any two layers is less than 2 ppm.

Applying the disclosed methods to situations in which the tooling pins 12 are larger in diameter than the registration holes 32 will likely require forcing the layers 30 onto the tooling pins 12. Providing tooling pins 12 with conical tips allows a layer to be positioned and to rest on the tooling pins 12 with a portion of the conical tips of tooling pins 12 extending into the registration holes 32 to insure proper alignment of the registration holes 32 and tooling pins 12 prior to forcing the layer onto tooling pins 12.

Thus, specific embodiments and applications of alignment plates have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

CLAIMS

What is claimed is:

1. A method of laminating comprising:
 - providing a plurality of layers to be laminated;
 - determining the thermal coefficient of expansion (TCE) of the plurality of layers;
 - providing an alignment plate having approximately the same TCE; and
 - stacking the plurality of layers onto the alignment plate.
2. The method of claim 1 further wherein the alignment plate comprises tooling pins; the method further comprises drilling registration holes in the layers to be laminated, the registration holes having a diameter at least as large as the diameter of the tooling pins of the alignment plate; and the step of stacking the plurality of layers onto the alignment plate comprises forcing the tooling pins through the registration holes of each layer of the plurality of layers.
3. The method of claim 2 wherein the tooling pins comprise a conical tip and the method further comprises the step of resting each layer of the plurality of layers on the tips of the tooling pins prior to forcing the tooling pins through the registration holes of each layer.
4. The method of claim 3 wherein the diameter of the registration holes is 0-5 μm smaller than the diameter of the tooling pins.
5. The method of claim 4 wherein the step of providing the plurality of layers comprises providing a plurality of layers, each layer of the plurality of layers having a TCE substantially similar to the TCE of each of the other layers of the plurality of layers.
6. The method of claim 5 wherein the greatest difference in TCE between any two layers is less than 2 ppm.

The method of claim 6 wherein the difference in TCE between the alignment plate and the average of the TCEs of the layers is less than 2 ppm.

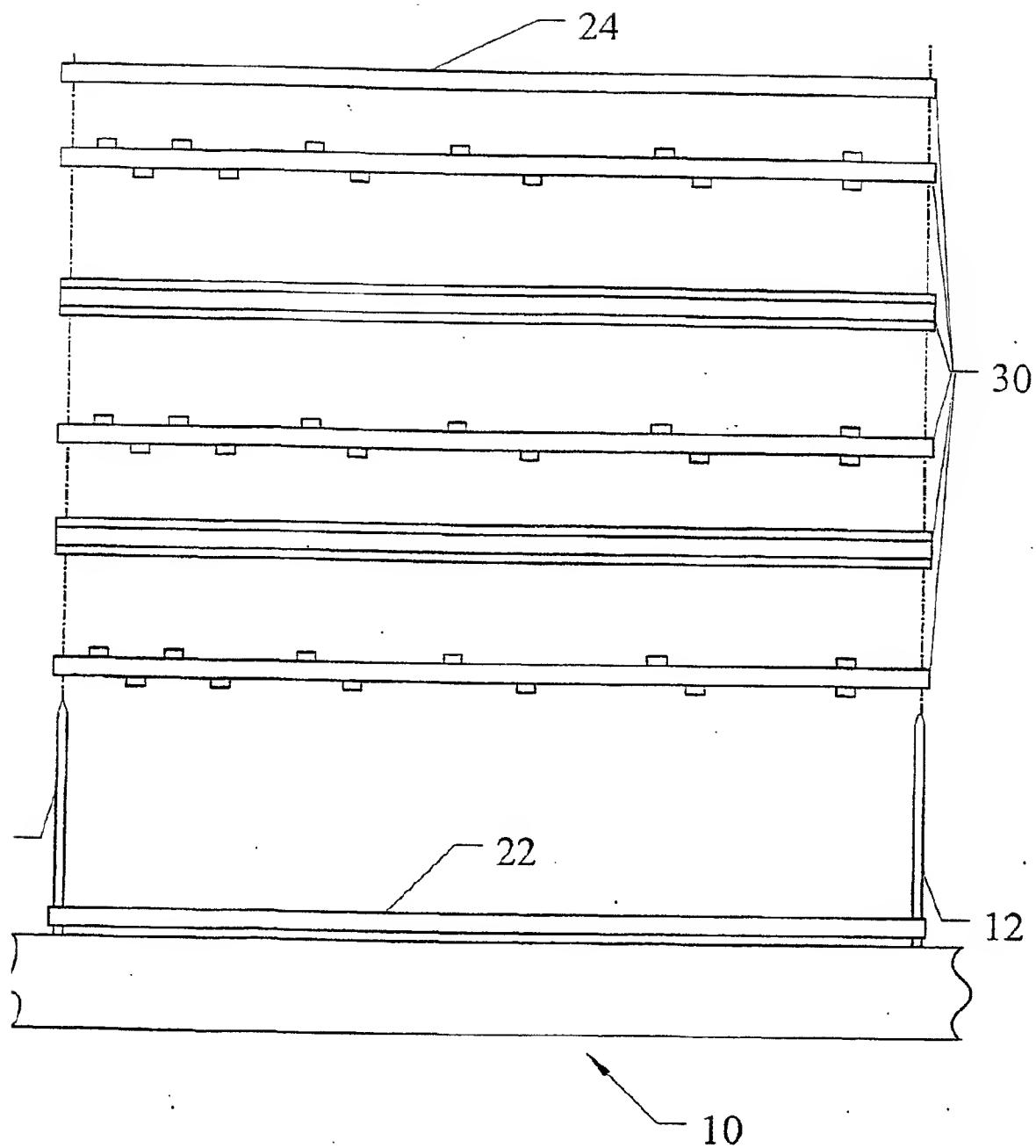


Fig. 1

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/05892

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K3/46 B32B31/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 768 772 A (BUECHELE) 23 June 1998 (1998-06-23) claims; figures ---	1-3
A	DE 41 16 543 A (SIEMENS NIXDORF INFORMATIONSSYSTEME AG) 26 November 1992 (1992-11-26) the whole document ---	1
A	"PEDESTAL PIN REGISTRATION SYSTEM FOR MULTI-LAYER LAMINATION" IBM TECHNICAL DISCLOSURE BULLETIN, IBM CORP. NEW YORK, US, vol. 31, no. 8, 1989, pages 141-142, XP000023791 ISSN: 0018-8689 the whole document ---	1,2 -/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the International search

Date of mailing of the International search report

10 July 2001

17/07/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nt,
 Fax: (+31-70) 340-3016

Authorized officer

Mes, L

INTERNATIONAL SEARCH REPORT

national Application No

PCT/US 01/05892

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 281 (M-624), 11 September 1987 (1987-09-11) & JP 62 082025 A (HITACHI CHEM CO LTD), 15 April 1987 (1987-04-15) abstract ---	1-3
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 11, 29 November 1996 (1996-11-29) & JP 08 186376 A (HITACHI LTD), 16 July 1996 (1996-07-16) abstract ---	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 15, 6 April 2001 (2001-04-06) & JP 2000 340898 A (KYOCERA CORP), 8 December 2000 (2000-12-08) abstract ---	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 326 (E-1235), 16 July 1992 (1992-07-16) & JP 04 097595 A (HITACHI LTD), 30 March 1992 (1992-03-30) abstract ---	1,2
A	DE 24 44 698 A (SIEMENS AG) 8 April 1976 (1976-04-08) page 4, paragraph 2 ---	1

INTERNATIONAL SEARCH REPORT

national Application No
PCT/US 01/05892

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 5768772	A	23-06-1998		JP 10051152 A US 5970606 A		20-02-1998 26-10-1999
DE 4116543	A	26-11-1992		NONE		
JP 62082025	A	15-04-1987		NONE		
JP 08186376	A	16-07-1996		NONE		
JP 2000340898	A	08-12-2000		NONE		
JP 04097595	8 A			NONE		
DE 2444698	A	08-04-1976		NONE		